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**Filters and Wavefront Dividing Beamsplitters for the
Near and Mid Infrared Produced by Micromachining Techniques***

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**Volume 2104**

Filters and Wavefront dividing Beamsplitters for the near and mid Infra. produced by Micromachining Techniques.

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Introduction

Band pass filters for the far infrared have been produced by etching crosses into metal films on Mylar substrates^{1,2}. Unsupported thin cross shaped filters for the far infrared have been produced by etching crosses into 4 microns thick nickel foils³. These authors studied the dependence of the wavelength of peak transmission, bandwidth, and percentage of peak transmission on the shape of the crosses. Very accurately shaped crosses in thick metals for the mid infrared have been produced using LIGA⁴. These filters showed a strong side peak and transmission in the 70% to 80% range. Theoretical calculations by Compton et al⁵ for thin filters predict such a side peak, depending on the shape of the cross, and 100% transmission. To obtain maximum transmission for band pass filters, a tripod shape was used⁶ instead of the cross. These filters showed 100% transmission and the side peak for a thickness of 10.5 microns. The side peak is getting smaller for thinner filters.

Band pass filters for the near and mid infrared.

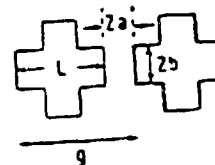
The above mentioned investigations suggest that thin filters are more transmissive and have a much smaller side peak. 100% transmission may be obtained by using pattern of tripods which are much denser "packed" than the crosses. The width and slopes of the filters are determined by the periodicity constants and the shape and size of the crosses. Since there is much more known how the transmission curve depends on these parameters for crosses than for tripods, we decided to develop band pass filters for the short wavelength region by

- using crosses in an arrangement as used before, and then
- produce new pattern with densely packed crosses.

We developed the filters without using synchrotron radiation but with a process similar to LIGA. Masks have been produced with periodicity constants of (A) 5.5, (B) 16.4, (C) 16.7, and (D) 26.4 microns. Using masks (B) and (D), filters with the following values have been produced:

Table 1

| | B | D ₁ | D ₂ |
|-----|------|----------------|----------------|
| g | 16.4 | 16.8 | 16.8 |
| a/g | .08 | .12 | .08 |
| b/g | .09 | .045 | .065 |



The filters were produced by first coating a chromium covered wafer with 1000Å gold. Then, using positive resist, the cross pattern was produced on the gold coating, see Fig.1.

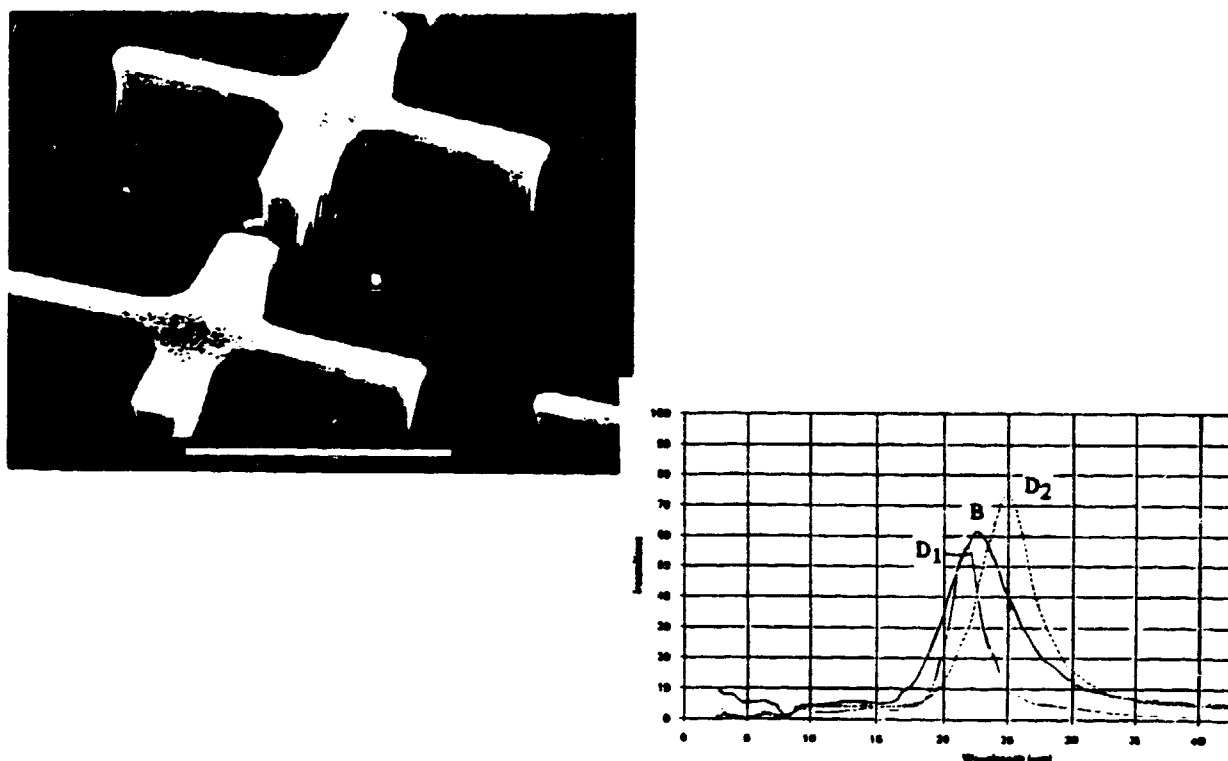


Fig.1 a. Cross made of photoresist. b. Transmission curves of filters of B, D₁ and D₂ of Table 1.

A 2-3 microns thick nickel film was formed around the crosses by using an electroforming process. The crosses of the photoresist were removed and the film taken off the wafer and mounted on a ring for support. At the end of the process the gold film was eliminated.

Micrographs of the actual crosses indicated that their shape and the corresponding transmission curve agree qualitatively with what would be predicted from the results of Ref.3. However, we found that the cross shape and size was not the same on both sides of the filter. The cross of Fig.1 shows clearly that the walls are not perpendicular to the plane of the cross and we think that this is the reason that the transmission curves are smooth and show no side peak. The "waveguide" of the cross is in our case distorted from a waveguide with parallel walls as has been produced with LIGA. This distortion seems to work for the advantage of a smooth curve without side peaks.

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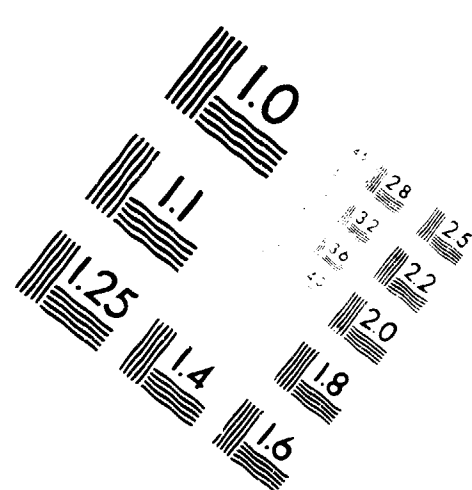
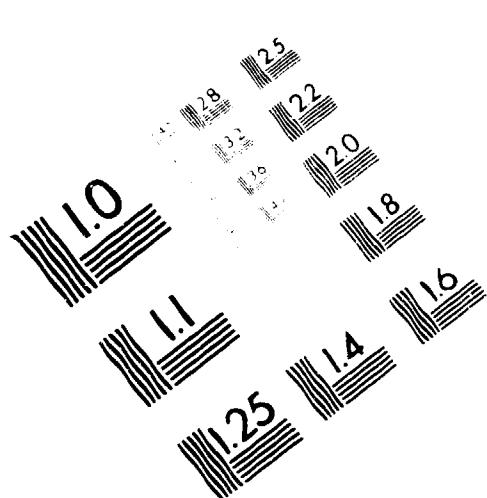
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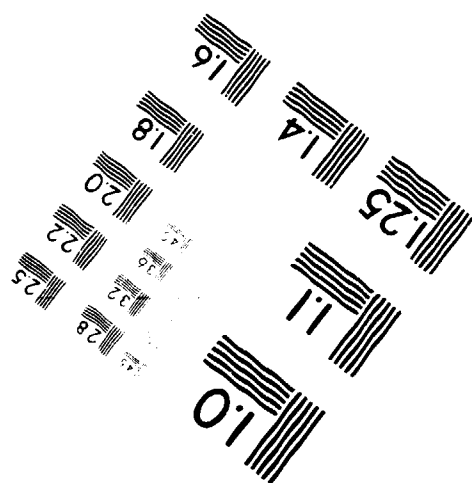
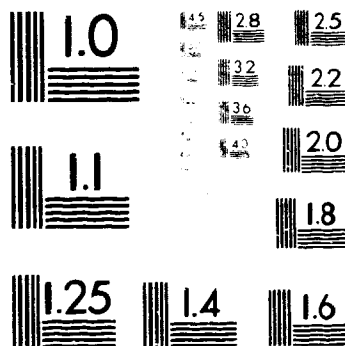
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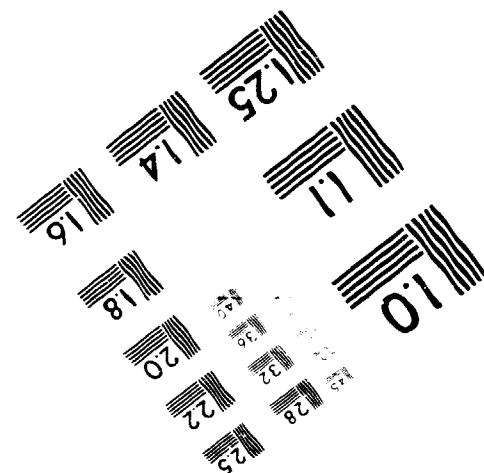
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